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(54) METHOD FOR PLASMA PROCESSING BY SHAPING AN INDUCED ELECTRIC FIELD

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- (*) Notice:

This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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Related U.S. Application Data

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(30) Foreign Application Priority Data

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(56) References Cited

U.S. PATENT DOCUMENTS

3,886,896	6/1975	Van Cakenberghe.	
4,292,153 *	9/1981	Kudo et al	427/570

4,434,742		3/1984	Henaff.
4,539,068	+	9/1985	Takagi et al 427/570
4,948,458		8/1990	Ogle .
4,985,109	٠	1/1991	Otsubo et al 427/575
4,989,542	*	2/1991	Kamo 427/575
5,091,049		2/1992	Campbell .
5,180,435		1/1993	Markunas .
5,277,751		1/1994	Ogle .
5,304,279		4/1994	Coultas .
5,401,350		3/1995	Patrick et al
5,433,812	*	7/1995	Cuomo et al 156/345
5,556,501	*	9/1996	Collins et al 204/298.34
5,560,776	•	10/1996	Sugai et al 118/723 I

FOREIGN PATENT DOCUMENTS

0 379 828 8/1990 (EP) . 4-290428 10/1992 (JP) .

OTHER PUBLICATIONS

Hideo Sugai, Kenji Nakamura and Keiju Suzuki, Electrostatic Coupling of Antenna and the Shielding Effect in Inductive RF Plasmas, Apr. 1994, pp. 2189–2193, Jpn J. Appl. Phys. vol. 33 (1994), Part 1, No. 4B.

* cited by examiner

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(57) ABSTRACT

A method for achieving a highly uniform plasma density on a substrate by shaping an induced electric field including the steps of positioning the substrate in a processing chamber. supplying a high frequency power to a spiral antenna generating an induced electric field in the processing chamber, generating a plasma in the processing chamber, and shaping the electric field with respect to the substrate to achieve a uniform distribution of plasma on the substrate being processed.

7 Claims, 14 Drawing Sheets

